Linkage between Agricultural Development Policies and Groundwater Management: Empirical Evidence in China

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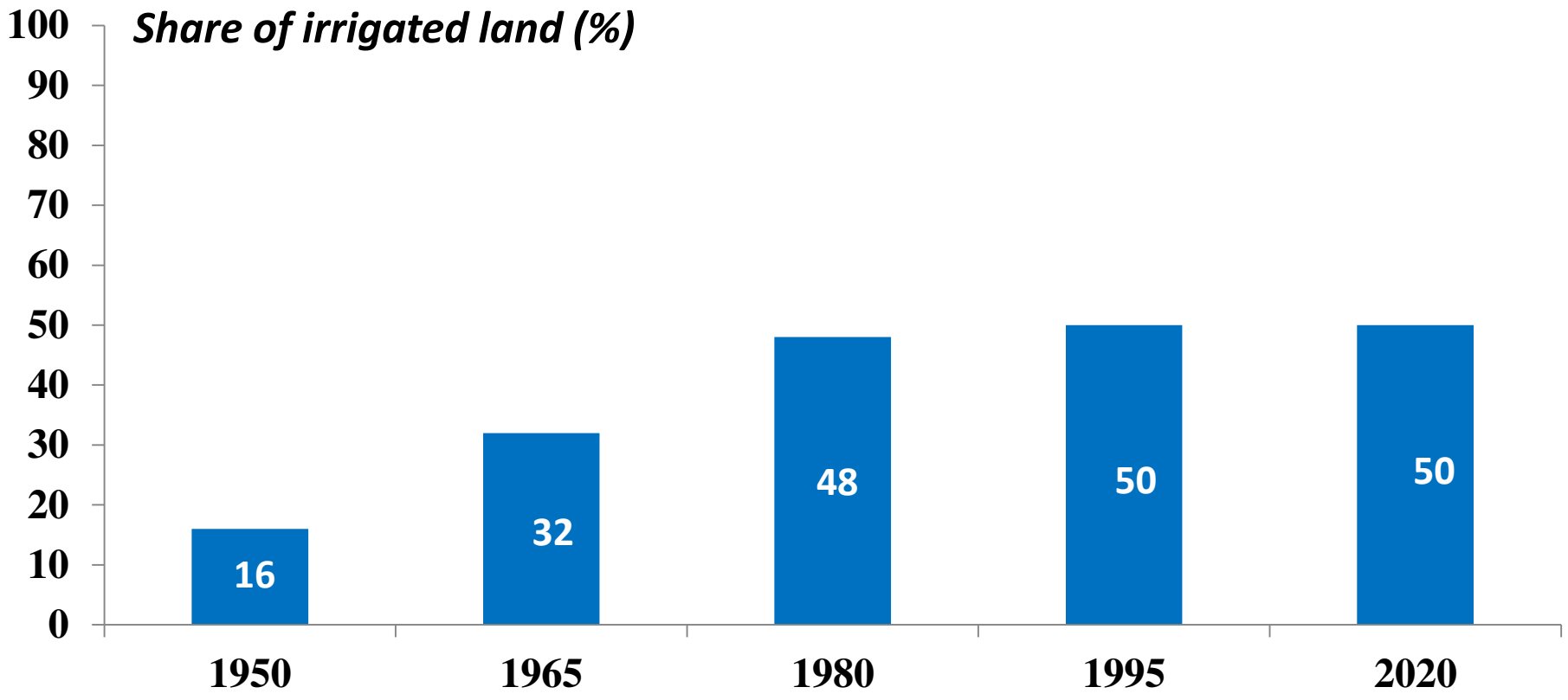
Groundwater management in China is significantly affected by agricultural development policies: How?

Three major policy targets of agricultural development in China:

- Ensure food security
- Increase farmer income
- Promote green and sustainable development

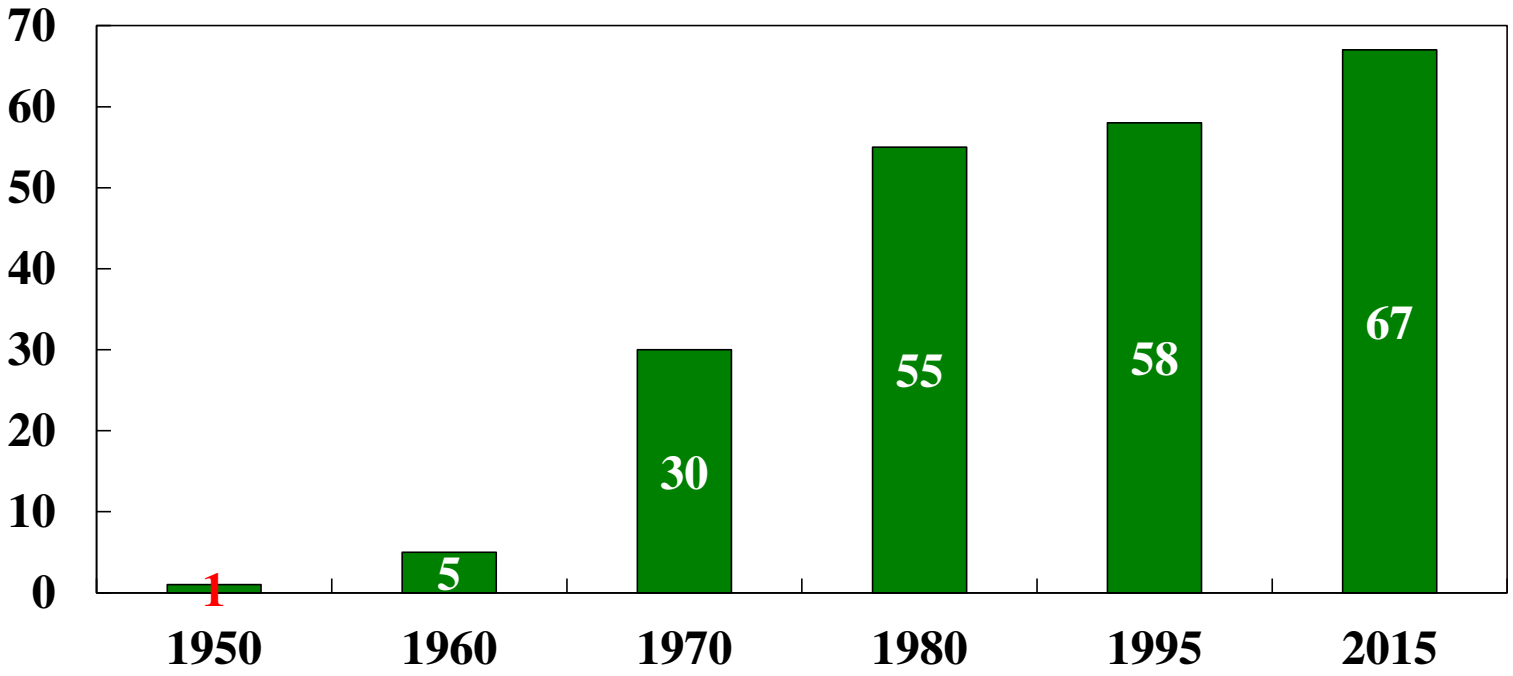
- In order to ensure food security, China's government has put much money into irrigation investment since 1950s
- Until now, agricultural production highly depends on irrigation



70% of grain production, more than 80% of cotton and 90% of vegetables' production depend on irrigated land

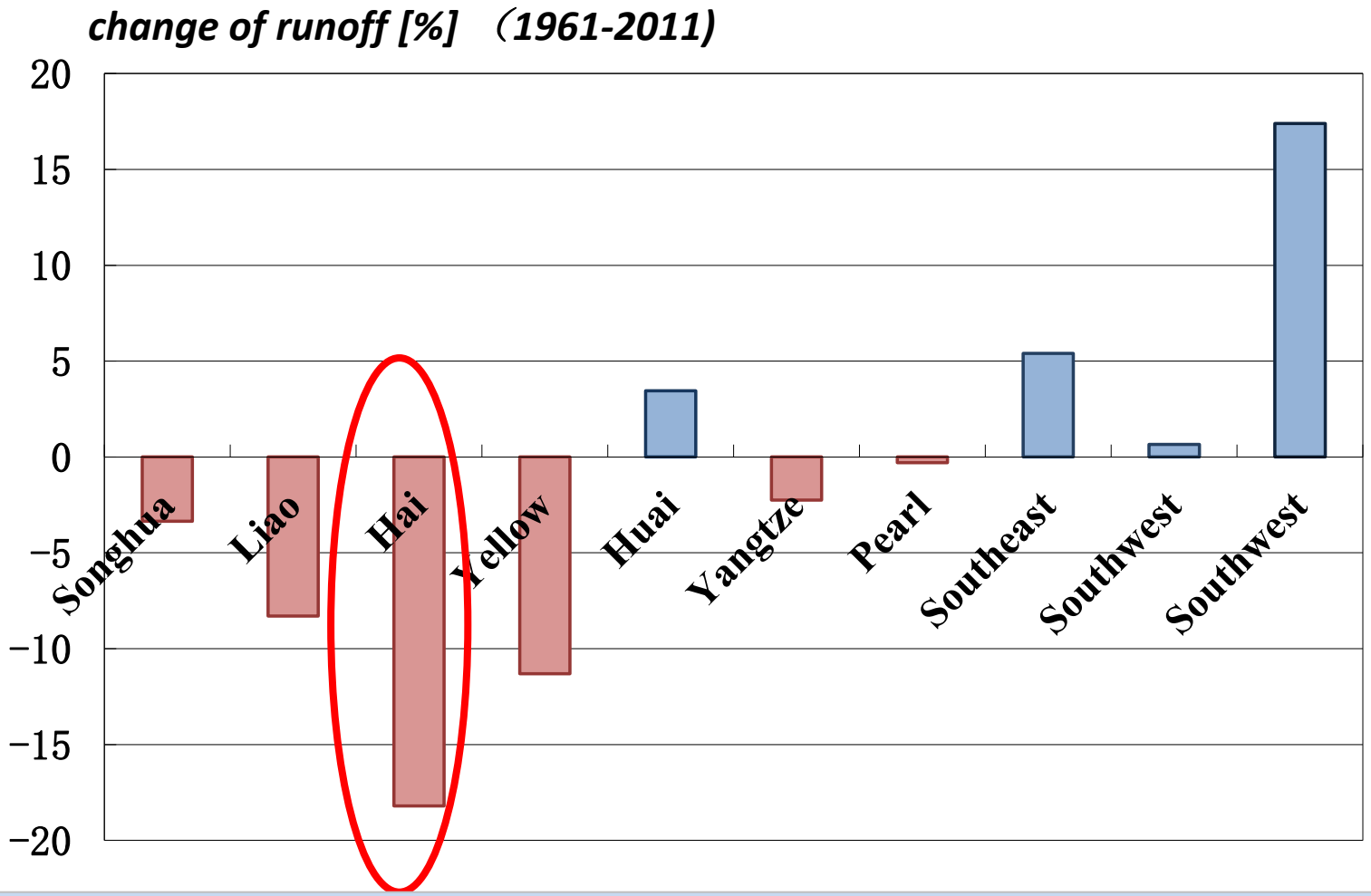
- After 1970s, exploration of groundwater has rapidly increased
- Until now, groundwater has become the major source of irrigation

Share of groundwater irrigated land areas in North China (%)



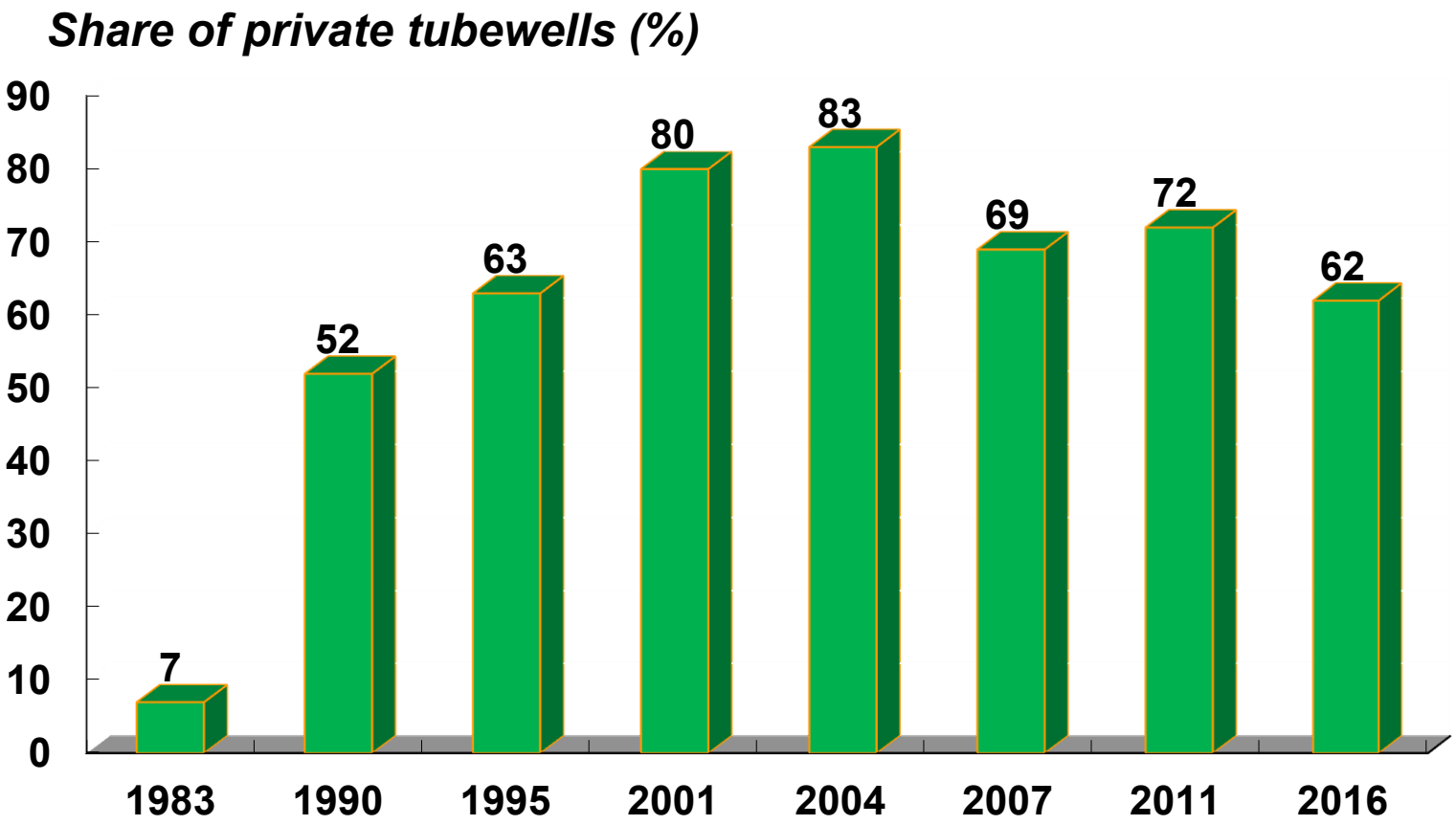
- Why?

● Supply of surface water resources has declined in the past several decades



- Comparing the two hydrological series before and after the 1980s (1980-2018/1956-1979), the measured river runoff in the Haihe River basin decreased by 30% to 70%.

- With the implementation of rural reform since the early1980s
- In order to increase agricultural productivity and income
- Individual farmers have become the major investors of agricultural tubewells



- **Although the privatization of tubewells benefit farmers by increasing their income through adjusting cropping patterns; It has accelerated the drop of groundwater table**

Dependent variables		Share of sown areas				Crop yield		Per capita income	GW table
		Wheat	Maize	Cotton	Other cash crops	Wheat	Maize		
Private tubewell (%)	Coe.	-3.0	2.8	0.10	0.06	182	-7.1	6.8	0.02
	t value	2.23**	1.83*	4.27**	2.39**	1.05	0.03	2.98***	7.19***

- After privatization, farmers have expanded the sown area of less water-sensitive and high-value crops;
- With the adjustment of cropping patterns, farmers' income significantly increased

Decline of groundwater table has become one common and serious issue in North China

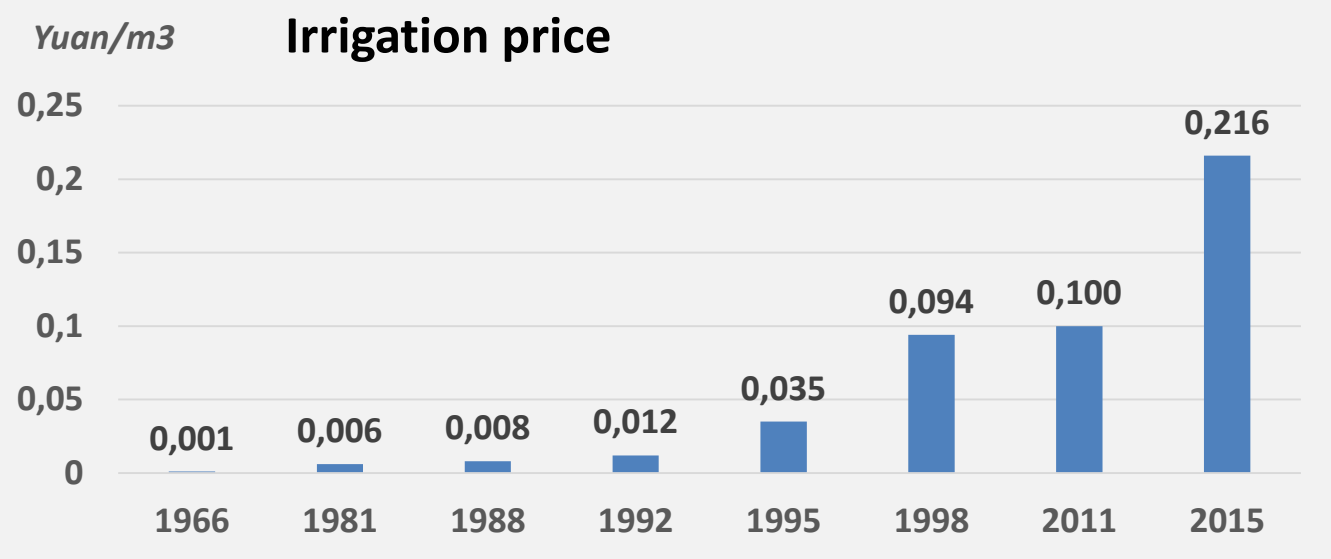
	Share of villages with decline of groundwater table (%)	Annual rate of decline of groundwater table (m/year) (proportion of villages)		
		<0.25	0.25-1.5	>1.5
1995-2004	64	17	39	8
2005-2015	75	10	31	34

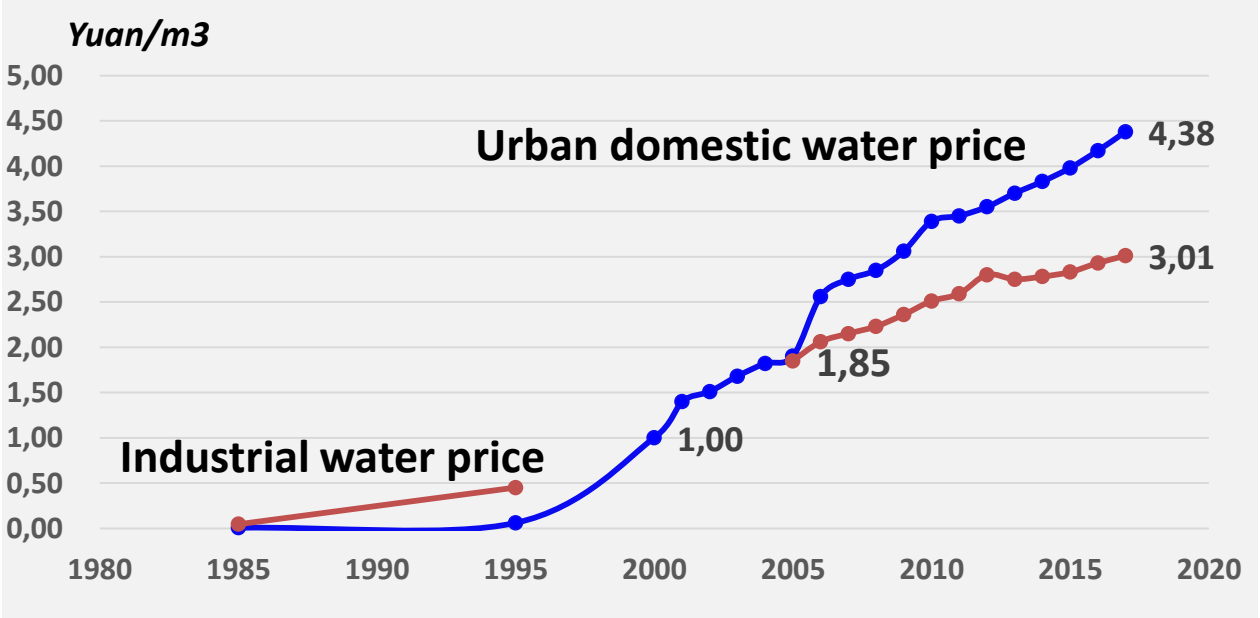
Source: North China Water Resource Survey (400 villages in 6 provinces), CCAP

How to promote the sustainable development of groundwater resources?

- Since 1990s, water management has begun to be transferred from supply to demand either in the developed or developing countries
- Among all measures, how to evaluate and realize the value of water resources has been highly addressed by both scholars and policymakers:
  - Reform of irrigation pricing policy
  - Implementing the payment for ecosystem services policy: Seasonal land fallowing policy

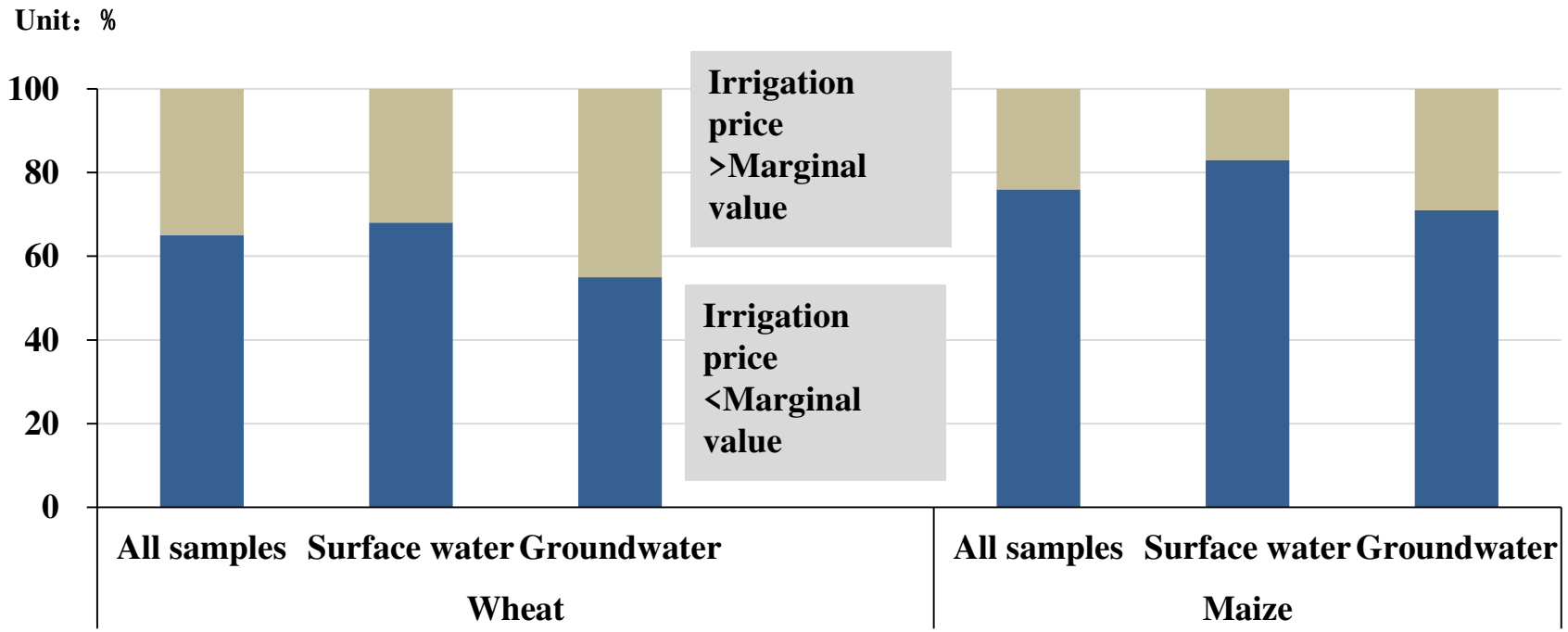
Despite some progress, the promotion of irrigation price reform is still slow





In most cases, irrigation price only can cover part of supply cost, lower than its marginal value

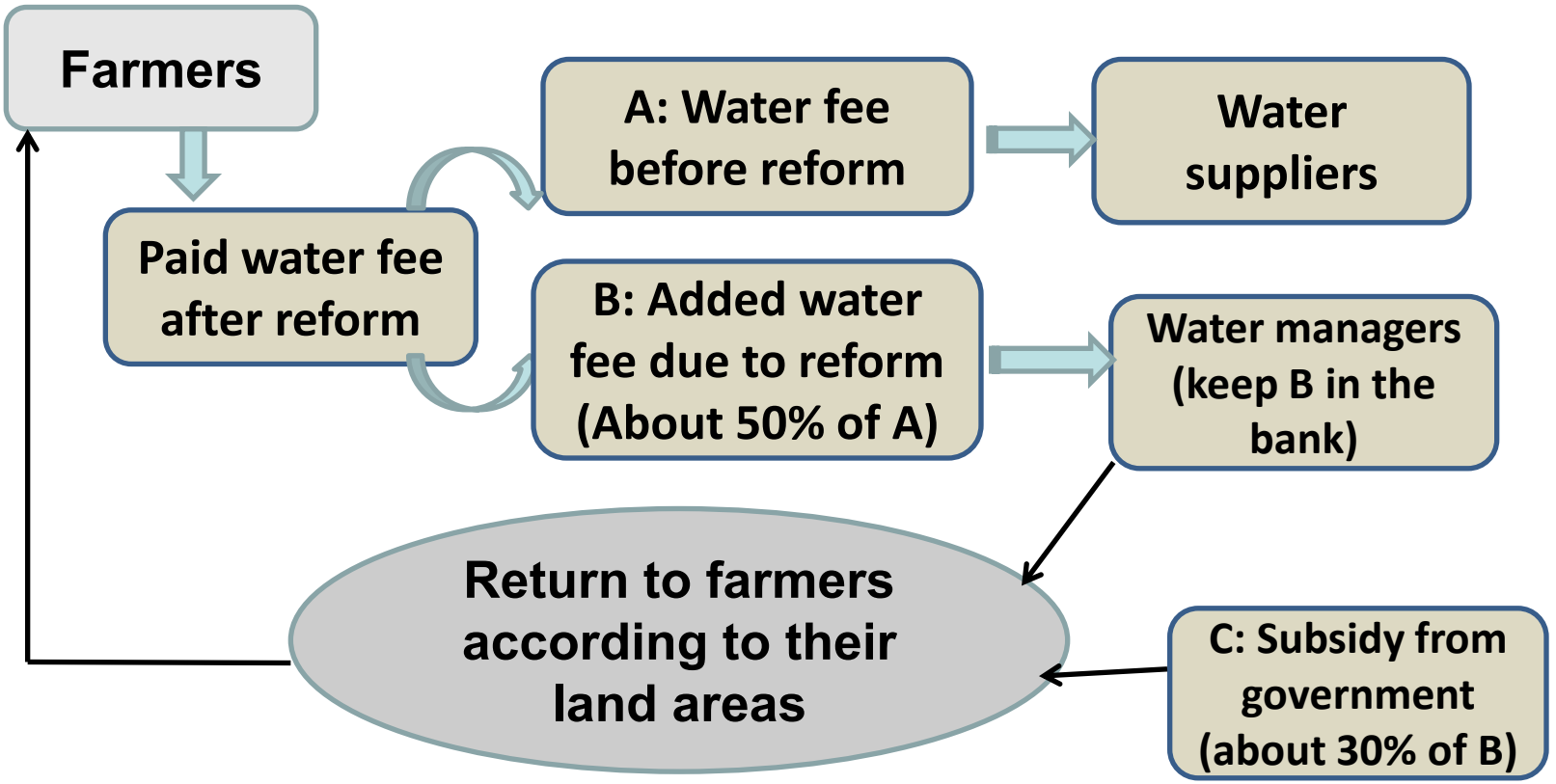
- Full Cost of consumption of water (value of water ecosystem services)
  = Full Economic Cost + Environmental Externalities.
- Full Economic Cost of water
  = Full Supply Cost + Opportunity Cost + Economic externalities
- Full Supply Costs =
  Operation and Maintenance (O&M) Cost + Capital Charges



Why the reform progress of irrigation price is so slow?

- **Lack of ability to measure volumes of water: hard to implement volumetric water pricing, collect water fee by areas that are not closely related with farmers' water use behavior**
- **Due to inelastic demand, increasing irrigation fee is conflict with the policy goal of raising farmer income.**
  - **Price elasticities of demand for groundwater for wheat is about –0.40**
  - **If the price of water were doubled, 75% of farmers would lose money on their cropping activities and there also would be a negative effect on ag-output**
- **How to implement win-win water price reform in agricultural sector?**

"Increase Price and Provide Subsidy" Pilot Reform in Hebei Province



In the pilot reform areas, farmers use GW and they pay irrigation fee based on their use of electricity for pumping

The difference between the returned money and payment was treated as an incentive for farmers to reduce their use of irrigation

The reform reduced irrigational application by 33% for wheat

	Log of wheat groundwater use (m^3/mu)		
	（1）	（2）	（3）
If really participated in the project (1=Yes; 0=No)	-0.319 (2.12)**	-0.335 (2.22)**	
If nominally participated in the project (1=yes; 0=No)		-0.236 (1.25)	
Change in irrigation water price (yuan/unit of electricity)			-1.377 (2.56)**

- Since local government provided subsidies to all farmers participated in the reform, most farmers earn some money due to the reform
- Due to high implementation cost and no financial subsidy sources, It still has not been extended to other regions since its initiation in 2005

Comprehensive Control of Groundwater Overdraft (CCGO) in North China Plain

Consistent with agricultural depromoting policies:
- Green and sustainable development

2014

- launch of pilot project of Comprehensive Control of Groundwater Overdraft (CCGO) in North China Plain
- Objective of CCGO: is to control and reduce the amount of groundwater extraction by various measures
- Hebei Province, the first pilot region

2017

- Expanded to Shandong, Shanxi and Henan Provinces

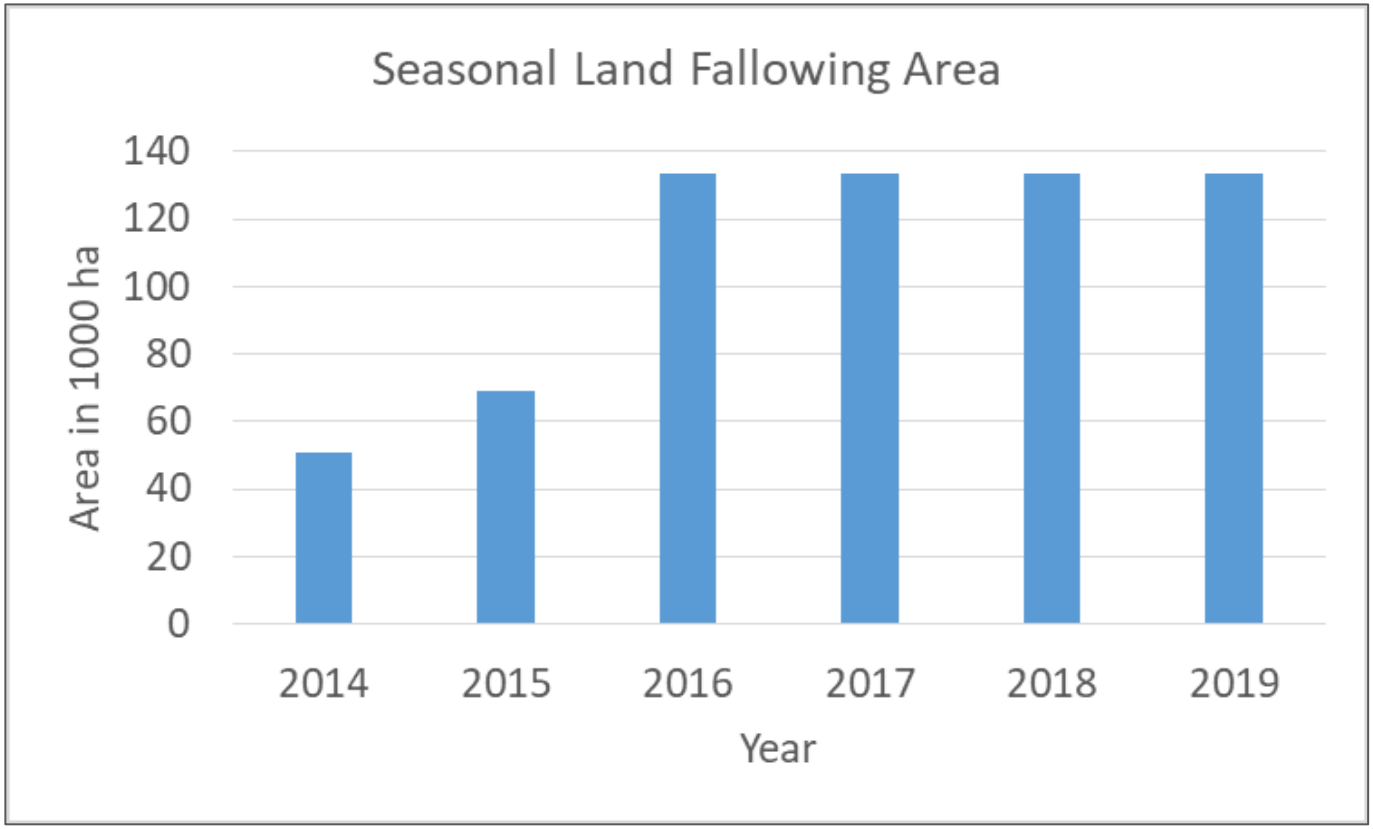
2020

- 13 provinces plan to implement the pilot project for controlling groundwater overdraft issues

CCGO in Hebei Province

Seasonal land fallowing policy:

- **Subsidize farmers by 500 RMB per mu**
- **Change the cropping system from two crops (winter wheat and corn) to one crop (only summer corn) a year**



SLFP: The payment for ecosystem services policy (PES)

Agricultural water saving per household

	SLFP households			Non-SLFP households		
	2017	2019	Change	2017	2019	Change
Agricultural water use per household (m^3)	2731	2343	-388	3966	4176	210

*Only includes SLFP households participating in SLFP in the winter of 2017 or 2018

- **SLFP can save agricultural water use per mu of about 122 m^3, which is 81% of policy target 140-160 m^3;**
- **However, considering its conflict with ensuring food security, the SLFP is hard to be extended to larger areas.**

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Thanks !

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